ORIGINAL ARTICLE

Clinical characteristics and factors associated with the hospital admission of people with Covid-19 monitored by telehealth

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ABSTRACT

Objective: to describe the clinical characteristics and analyze the factors associated with hospitalization of patients treated by a public teleconsultation and telemonitoring service for suspected cases of COVID-19 (TeleCOVID-MG). **Method:** cross-sectional study with analysis of electronic records of patients with flu-like syndrome, treated by TeleCOVID-MG between May 2020 and December 2021. The outcome was the need for hospitalization registered in the Influenza Epidemiological Surveillance Information System (SIVEP-Gripe) or self-reported by the patient. Logistic regression was performed to assess the independent association of the explanatory variables with the outcome, with a significance level of 5 %. **Results:** 8,325 patients were treated, 63.1 % female, 8.3 % aged 60 years or older, and 36.6 % with some risk comorbidity, with 11 % reporting signs of severity, and 169 (2.0 %) patients requiring hospitalization. The factors independently associated with hospitalization were: male (OR_{aj}: 2.04; 95%CI 1.46-2.85); age between 40 and 59 years (OR_{aj}: 4.09; 95%CI 2.65-6.32) or over 60 years (OR_{aj}: 14.86; 95%CI 9.33-23.68); rheumatological (OR_{aj}: 2.50; 95%CI 1.11-5.62) or oncological (OR_{aj}: 3.02; 95%CI 1.27-7.16) diseases; report of dyspnea (OR_{aj}: 3.00; 95%CI 2.05-4.39); fever (OR_{aj}: 2.06; 95%CI 1.48-2.87); cough (OR_{aj}: 1.67; 95%CI 1.13-2.45); myalgia (OR_{aj}: 2.54; 95%CI 1.81-3.57); and runny nose (OR_{aj}: 1.93; 95%CI 1.38-2.70). **Conclusion:** recognizing populations susceptible to severe forms of COVID-19 can guide clinical management to prevent complications, in addition to contributing to the strategic planning of the health care network in line with in-person health services.

Keywords: COVID-19, Epidemiology, Natural history of diseases, Telemedicine, Telemonitoring.

INTRODUCTION

Due to the high transmissibility and potential severity of cases, the COVID-19 pandemic has overloaded the health system, resulting in high rates of hospitalization and death[1-2]. As of October 2024, more than seven million deaths from COVID-19 have been reported worldwide, with more than 700,000 deaths in Brazil alone[3-4].

From its transmission, which usually occurs through contact with respiratory secretions expelled through speech, coughing, and sneezing[5], COVID-19 presents with an acute respiratory condition, with the presence of fever, chills, cough, odynophagia, headache, runny nose, and olfactory and taste disorders. Some patients may progress to Severe Acute Respiratory Syndrome (SARS), when dyspnea, respiratory distress, and hypotension may occur, requiring hospitalization[6-7]. According to the Epidemiological Surveillance (ES) guidelines, all hospitalized patients with SARS must be

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reported by hospital health services into the Influenza Epidemiological Surveillance Information System (*Sistema de Informação da Vigilância Epidemiológica da Gripe* - SIVEP-Gripe)[7].

The hospitalization rates for COVID-19 vary according to the age group and previous health conditions of the patients[8-9]. Therefore, in the clinical and management approach, it is of utmost importance for health professionals to identify warning signs and severity, including changes in respiratory and hemodynamic patterns - arterial hypotension, drop in oxygen saturation, worsening of previous clinical conditions, and changes in mental state[6,10]. Therefore, careful and continuous analysis of signs of severity is essential, taking into account the clinical and epidemiological evaluation of each case, providing support for assessing the need for hospitalization and avoiding more severe complications[6].

With the progressive advance of the COVID-19 pandemic and the exhaustion of the capacity of health services, political and health organizations adopted practices of hand hygiene, use of masks, isolation and social distancing as the main measures to control the spread of the virus. In this context, telehealth actions became essential strategies in the fight against the pandemic, as they enabled support to health systems, mainly in the public sectors, in the scope of prevention and clinical care, support for training and continuing education in health (*Educação Permanente em Saúde* - EPS)[11]. Telehealth emerged from an expansion of telemedicine, with the involvement of a multidisciplinary team in the provision of health care through the use of information and communication technologies (ICT) for remote care to the population, in addition to increasing accessibility to health services and offering efficient, systematized, and low-cost interventions[12-13].

During the pandemic, the Ministry of Health (MH) and the Federal Council of Medicine (*Conselho Federal de Medicina* - CFM) changed the telehealth regulations in Brazil, allowing virtual interaction between health professionals and patients for pre-clinical care, support, consultation, monitoring and diagnosis[6,14]. The telehealth model developed in Brazil is connected to Federal Higher Education Institutions (*Instituições Federais de Ensino Superior* - IFES) and Primary Health Care (PHC), through tele-education and tele-assistance activities, with the aim of strengthening the Family Health Strategy (FHS)[15]. Thus, this partnership was fundamental in tackling the COVID-19 pandemic, as, in addition to expanding access to care, it contributed to reducing the flow of people in health services and decreasing the circulation of the virus in the community[11].

From this perspective, early identification of patients with flu-like syndrome (FS), especially those with comorbidities and risk factors, allows for immediate initiation of appropriate treatment and support, in addition to facilitating rapid referral of patients for hospitalization, following institutional protocols and national recommendations. In contrast, patients with mild to moderate respiratory symptoms and no risk factors were advised to remain at home, with the possibility of being evaluated and monitored by the telehealth service[6].

There are still many challenges to the use of telehealth in pandemic situations, including aspects related to the need for physical examination and complementary evaluation procedures, in addition to issues of social vulnerability leading to dif-

ficulty in accessing the Internet[16]. However, telehealth has emerged as an important strategy to be implemented even in a post-pandemic scenario, since it can contribute to the improvement of public policies aimed at health promotion, prevention, treatment, and education, and is suitable for the management of other health conditions. To this end, the interaction of remote care associated with in-person care is important[17]. Therefore, it is essential to develop and implement specific care protocols for telehealth, as some patients will continue to require in-person clinical evaluation to perform a physical examination and additional tests to assist in the diagnosis and define the therapeutic approach[16]. In this way, telehealth can significantly contribute to strengthening the Public Health System (*Sistema Único de Saúde* - SUS) in Brazil.

Outpatient clinical management through remote care is considered adequate for the vast majority of COVID-19 cases, as it presents a mild condition without major complications[18]. However, there is a shortage of studies aimed at evaluating the use of telehealth as a strategy to combat COVID-19 in relation to clinical outcomes, which can help define eligibility criteria for remote care for patients with acute clinical symptoms of FS compatible with COVID-19[16,18-19].

Thus, the main objective of this study was to describe the clinical characteristics and analyze the factors associated with hospital admission of patients treated by a public teleconsultation and telemonitoring service for suspected cases of COVID-19 (TeleCOVID-MG).

METHOD

Study Design and Setting

This is a cross-sectional study developed based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE Statement)[20] criteria for conducting and presenting the study.

The study site is a medium-sized municipality located in the central-west region of the state of Minas Gerais (MG), in Brazil, with an estimated population of 231,091 inhabitants and a Human Development Index (HDI) in 2010 of 0.7621. In 2020, the year the COVID-19 pandemic emerged, the municipality's health care network was structured by 43 PHC units (32 FHS teams and 11 conventional health centers), an emergency care unit (*Unidade de Pronto-atendimento* - UPA), a specialized polyclinic, a home care service, a large philanthropic hospital that provides services to the SUS, and three medium-sized private hospitals. In addition, the Municipal Health Department temporarily set up (in 2020 and 2021) a field hospital with 20 observation beds and 30 intensive care unit (ICU) beds[21-22].

In this same context, a structured public teleconsultation and telemonitoring service for suspected cases of COVID-19 (TeleCOVID-MG) was set up, developed by the Minas Gerais Telehealth Network (*Rede de Telessaúde de Minas Gerais* - RTMG), one of the largest public telehealth services in Latin America, linked to the Telehealth Center of the Clinical Hospital (*Hospital das Clínicas*) of the Federal University of Minas Gerais (UFMG), in partnership with the Federal University of São João del-Rei

(UFSJ), which is one of the RTMG centers, and the Municipal Health Department (*Secretaria Municipal de Saúde* - SEMUSA) of the municipality under study. TeleCOVID-MG had three main purposes: 1) to evaluate and monitor patients with acute respiratory symptoms; 2) monitor COVID-19 patients during the respiratory isolation period; and 3) provide general assistance to the population with updated information about COVID-19. TeleCOVID-MG provided assistance in three municipalities in MG, and the actions developed in the municipality under study were carried out from May 2020 to December 2021, with telephone consultations carried out by healthcare professionals on shifts ranging from six to twelve hours, from Monday to Friday. The consultations were carried out at four levels of care: I) triage by telephone call or chatbot application; II) nursing teleconsultation; III) medical teleconsultation; and IV) telemonitoring. The teleconsultations carried out by healthcare professionals at levels II, III, and IV were structured. All professionals involved received periodic training throughout the implementation of the consultation, with training in the use of the tool and with discussions on the approach and clinical management of cases. The services followed the guidelines recommended in technical documents from the World Health Organization (WHO) and the MH, adapted locally, under the guidance and supervision of a specialized technical team[17,23].

The population served by TeleCOVID-MG consisted of people with acute respiratory symptoms, referred from level I to levels II or III according to priority of care (presence of warning signs and severity and/or presence of risk comorbidities). All patients treated were registered in the COVID-19 Notifiable Diseases Information System for Epidemiological Surveillance (*Sistema de Informação de Agravos de Notificação da COVID-19 da Vigilância Epidemiológica* - SINAN e-SUS VE)[7] and monitored by the telemonitoring team (level IV), composed of medical students supervised by medical professors. Telemonitoring was carried out every 24 hours for patients over 60 years of age or with the presence of risk of comorbidities, and every 48 hours for others, until discharge from home isolation, initially after 14 days and subsequently after seven days from the onset of symptoms, following official health recommendations. Patients agreed to receive remote care by means of consent recorded in a consent form[17,23]. The request and performance of diagnostic tests followed local and MH flows and recommendations[6-7].

In the context of PHC, the municipality had three types of tests available: 1) Reverse Transcriptase Reaction followed by Polymerase Chain Reaction (RT-PCR) in respiratory secretion samples; 2) Rapid Antigen Detection Test (RT-Ag) in respiratory secretion samples; and 3) Rapid Antibody Detection Test (RT-Ab) in blood samples. In the first months of the pandemic and the implementation of TeleCOVID-MG, the RT-PCR test was only available for healthcare professionals, the elderly, severe clinical cases, and patients with comorbidities; access was later expanded to other cases. Patients were referred to Basic Health Units (*Unidades Básicas de Saúde* - UBS) or FHS to perform diagnostic tests according to the clinical management protocol established in the municipality[22]. When available, the test results were reported by the patients and recorded in the medical records during telemonitoring consultations.

Study population and data source

The population was defined as all electronic records of adult patients treated by TeleCOVID-MG in the municipality under study. The following eligibility criteria were considered: a) patients treated and monitored by the TeleCOVID-MG team between May 2020 and December 2021; b) age 18 years or older; and c) presence of acute respiratory clinical symptoms suspected or confirmed to be COVID-19.

Data were collected from secondary sources through the electronic medical records of patients treated by TeleCOVID-MG and the SIVEP-Gripe records, provided by the ES of the municipality under study[7].

Study variables

The response variable was the need for hospitalization due to SARS, defined by the presence of a hospitalization record in SIVEP-Gripe or self-report of hospitalization obtained directly from the patient during the teleconsultation on TeleCOVID-MG.

The explanatory variables analyzed were: a) sociodemographic: sex, age; b) clinical: presence of self-reported comorbidities (including systemic arterial hypertension (SAH), diabetes mellitus (DM), obesity with body mass index (BMI) higher than 30 kg/m^2, chronic heart disease, chronic lung disease, rheumatological diseases, chronic nephropathies, oncological diseases, and post-transplant immunosuppressive condition), presence of self-reported warning or severity signs (dyspnea or arterial hypotension), presence of self-reported acute symptoms (fever, cough, myalgia, odynophagia, headache, runny nose, anosmia); and c) related to health care: testing for COVID-19, result of the COVID-19 test, and referral for in-person evaluation at the UBS or UPA. These variables were collected in the first consultation of the acute phase or during telemonitoring.

Data collection and processing procedures

In order to maintain methodological rigor, reduce analysis bias that could compromise internal and external validity, and avoid sample losses, the following data processing criteria were established according to the methodological framework[24]: 1) identification and exclusion of duplicate (identical) records; 2) identification of multiple (non-identical) records of the same patient with care provided in the same period, keeping only the most consistent record for each patient; 3) identification of multiple (non-identical) records of the same patient with care provided in different periods, keeping only the last record; and; 4) exclusion of records lacking any clinical information.

The TeleCOVID-MG and SIVEP-Gripe databases were joined by convergence using the linkage method, using the individual taxpayer registration number (CPF) as the main linking variable, to pair identical records for subsequent data analysis[24]. For patients without a CPF number in any of the databases, a manual search was performed in other available databases (e-SUS-VE and TeleCOVID-MG), considering the full name and date of birth.

Data analysis

A descriptive analysis of the population was performed by obtaining the absolute and relative frequencies of the cate-

gorical variables and measures of central tendency for the continuous variables. The association between the explanatory variables and the response variable (hospital admission) was assessed using contingency tables with Chi-square calculation and p-value. The magnitude of the association was estimated by the Odds Ratio (OR), with a 95 % confidence interval (95%CI). The assessment of possible multicollinearity between the explanatory variables was performed by analyzing the correlation matrix and calculating Pearson's correlation coefficient. A multivariate analysis was then performed using Multiple Logistic Regression. To construct the initial model, the variables that had a p-value less than 0.20 in the bivariate analysis were included. After sequential exclusion of adjusted variables with non-significant association, only variables with p-values lower than 0.05 remained in the final model. The significance level adopted in the analyses was 0.05. The quality of the adjustment of the final model was assessed using the Hosmer-Lemeshow test. Data from both databases were made available in a Microsoft Excel® file and analyzed using EpiInfoTM version 7.2.2.6 for Windows and the Statistical Analysis System (SAS®) University Edition, free version (SAS® OnDemand for Academics).

Ethical Aspects

The research was approved by the Ethics Committee for Research Involving Human Beings of the Dona Lindu Central West Campus of UFSJ, under the Certificate of Presentation for Ethical Assessment (CAAE) number 37195820.1.0000.5545, opinion number 4,614,603, dated March 26, 2021, in accordance with Resolution No. 466/2012 of the National Health Council (*Conselho Nacional de Saúde* - CNS) that regulates research involving human beings.

RESULTS

The initial TeleCOVID-MG database consisted of 9,392 records, of which 1,067 were excluded for the following reasons: duplicate records of the same acute condition (n=173), duplicate records of different acute conditions (n=56), and records without any clinical information (n=838). Thus, after cleaning and editing the databases, the final sample of the TeleCOVID-MG database consisted of 8,325 records (Figure 1). In contrast, the initial SIVEP-Gripe database consisted of 4,187 records, of which 105 were excluded due to duplication (n=20) and subsequent hospitalization records (n=85).

After linking the databases, 138 patients treated through TeleCOVID-MG who had a record of hospital admission in SIVEP-Gripe were identified. In addition, another 31 patients reported during the teleconsultation, hospital admission for FS with some complication or SARS, despite there being no record in SIVEP-Gripe, resulting in a total of 169 (2.0 %) patients treated through TeleCOVID-MG with some record of hospital admission for SARS.

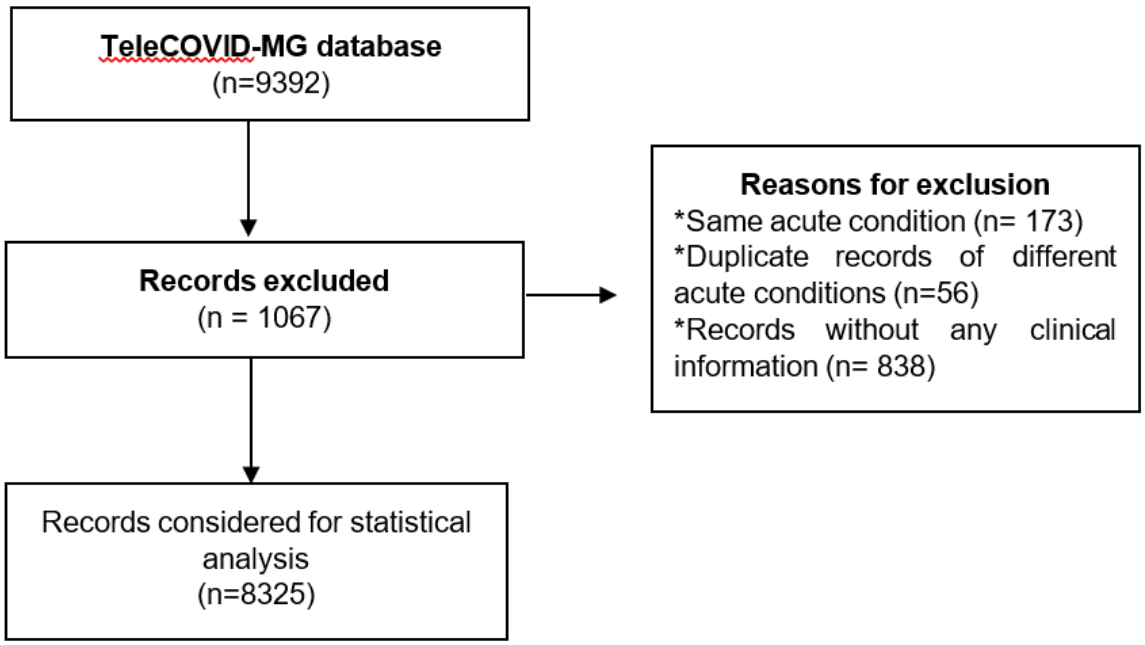

Figure 1- Flowchart of the selection of the eligible sample from the TeleCOVID-MG database. Divinópolis, MG, Brazil, 2023

Source: Prepared by the authors

Note: TeleCOVID-MG: teleconsultation and telemonitoring service for patients with flu-like syndrome (FS) in the state of MG.

Among the 8,325 patients attended by TeleCOVID-MG, 63.1 % were female and 56.5 % were between 18 and 39 years of age. The most frequent self-reported pre-existing comorbidities were: obesity - BMI greater than 30 kg/m^2 (24.7 %), SAH (17.6 %), and DM (6.0 %). The self-reported clinical manifestations in the acute phase were: headache (61.0 %), cough (51.2 %), and runny nose (43.0 %). The least frequent were: odynophagia (37.1 %), fever (33 %), anosmia (31.0 %), and myalgia (20.7 %). The mean period between the onset of symptoms and seeking telecare was four days. Regarding warning signs or severity, 11.0 % of patients reported having dyspnea or hypotension. Of the patients treated, 43.4 % were tested for COVID-19 and 27.2 % tested positive for the disease. Regarding referrals to in-person health services, 3.5 % of patients were referred for evaluation at the UBS and 6.5 % to the UPA (Table 1).

Table 1 - Sociodemographic and clinical characteristics of patients attended by the structured teleconsultation and telemonitoring service for suspected cases in the acute phase of COVID-19 (TeleCOVID-MG). Divinópolis, MG. Brazil. 2023 (n=8,325)

Characteristics	N*	(%)
Sex		
Female	5253	63.1
Male	3072	36.9
Age		
18-39 years	4703	56.5
40-59 years	2933	35.2
60 years +	689	8.3
Comorbidities		
Diabetes Mellitus (DM)		
Yes	474	6.0
No	7767	94.0
Systemic Arterial Hypertension (SAH)		
Yes	1450	17.6
No	6792	82.4
Chronic heart disease		
Yes	224	2.7
No	8101	97.3
Chronic lung disease		
Yes	727	8.8
No	7598	91.2
Obesity (BMI† > 30 Kg/m²)		
Yes	1353	24.7
No	4132	75.3
Rheumatological diseases		
Yes	113	1.4
No	8212	98.6
Kidney diseases		
Yes	18	0.2
No	8307	99.8
Oncological diseases		
Yes	61	0.7
No	8264	99.3
Post-transplant immunosuppressor condition		
Yes	7	0.1
No	8165	99.9

Clinical manifestations related to FS ‖		
Fever		
Yes	2730	33.0
No	5581	67.0
Cough		
Yes	4267	51.2
No	4058	48.8
Myalgia		
Yes	1715	20.7
No	6578	79.3
Odynophagia		
Yes	3075	37.1
No	5209	62.9
Headache		
Yes	5048	61.0
No	3253	39.0
Runny Nose		
Yes	3563	43.0
No	4733	57.0
Anosmia		
Yes	2554	31.0
No	5701	69.0
Warning signs/Severity		
Yes	900	11.0
No	7425	89.0
Dyspnea		
Yes	772	9.3
No	7553	90.7
Arterial hypotension		
Yes	220	2.6
No	8105	97.4
Testing for COVID-19		

Performed test for COVID-19		
Yes	3613	43.4
No	4712	56.6
Test result for COVID-19		
Positive	2266	27.2
Negative	6059	72.8
Received referral to UBS§[§]		
Yes	293	3.5
No	8032	96.5
Received referral to UPA[//]		
Yes	541	6.5
No	7784	93.5
Needed hospitalization[¶]		
Yes	169	2.0
No	8156	98.0

Source: Prepared by the authors (Databases - Telecovid-MG and Influenza Epidemiological Surveillance Information System - SIVEP-Gripe).

Note: *Excluded missing data; ‖FS = Flu-like syndrome; † BMI = body mass index; §UBS = Basic Health Unit; // UPA = Emergency Care Unit; In accordance with records in the Influenza Epidemiological Surveillance Information System (SIVEP-Gripe).

Bivariate analysis showed that the following variables were significantly associated with a greater chance of hospitalization from SARS: being male (OR: 1.88; CI95% 1.38-2.55); being between 40 and 59 years old (OR: 4.08; CI95% 2.66-6.25) and greater than 60 years (OR: 15.90; CI95% 10.25-24.80); reported DM diagnosis (OR: 3.95; CI95% 2.64-5.91); SAH (OR: 3.53; CI95% 2.58-4.84); chronic heart disease (OR: 2.86; CI95% 1.56-5.23); obesity (OR: 1.97; CI95% 1,26-3,09); rheumatological diseases (OR: 4.35; CI95% 2.16-8.75); chronic nephropathies (OR: 6.09; CI95% 1.38-26.7) or cancer diseases (OR: 6.48; CI95% 2.90-14.46); reported fever (OR: 2.40; CI95% 1.76-3.26); cough (OR: 2.17; CI95% 1.52- 3.11); myalgia (OR: 3.11; CI95% 2.28-4.23) or runny nose (OR: 1.93; CI95% 1.41-2.63); reported the presence of dyspnea (OR: 4.32; CI95% 3.08-6.07) or hypotension (OR: 3.20; CI95% 1.78-5.70); positive test for Covid-19 (OR: 1.87; CI95% 1.37-2.55) and received referral to the UPA (OR: 4.10; CI95% 2.80-5.99) (Table 2) .

Table 2 - Factors associated with hospitalization of patients attended by the structured teleconsultation and telemonitoring service in the acute phase of COVID-19 (Telecovid-MG), bivariate analysis. Divinópolis, MG. Brazil, 2023 (n = 8,325)

Clinical characteristics	N Total	N*	(%)	OR† (95% CI)	*P value*
Sex					
Female	5253	81	(1.5)	1.00	**<0.001**
Male	3072	88	(2.9)	1.88 (1.38-2.55)	
Age					
18-39 years	4703	30	(0.6)	1.00	
40-59 years	2933	75	(2.5)	4.08 (2.66-6.25)	**<0.001**
60 years +	689	64	(9.3)	15.90 (10.25-24.80)	
Comorbidities					
Diabetes Mellitus (DM)					
No	7767	135	(1.7)	1.00	**<0.001**
Yes	474	31	(6.5)	3.95 (2.64-5.91)	
Systemic Arterial Hypertension (SAH)					
No	6792	96	(1.4)	1.00	**<0.001**
Yes	1450	70	(4.8)	3.53 (2.58-4.84)	
Chronic heart disease					
No	8101	157	(1.9)	1.00	**<0.001**
Yes	224	12	(5.4)	2.86 (1.56-5.23)	
Chronic pneumopathies					
No	7598	155	(2.0)	1.00	0.834
Yes	727	14	(1.9)	0.94 (0.54-1.63)	
Obesity (BMI§> 30Kg/m²)					
No	4132	50	(1.2)	1.00	**0.002**
Yes	1353	32	(2.4)	1.97 (1.26-3.09)	
Rheumatological diseases					
No	8212	160	(2.0)	1.00	**<0.001**
Yes	113	9	(8.0)	4.35 (2.16-8.75)	
Kidney diseases					
No	8307	167	(2.0)	1.00	**0.006**
Yes	18	2	(11.1)	6.09 (1.38-26.7)	

Oncological diseases					
No	8264	162	(2.0)	1.00	**<0.001**
Yes	61	7	(11.5)	6.48 (2.90-14.46)	
Post-transplant immunosuppressor condition					
No	8165	163	(2.0)	1.00	**0.020**
Yes	7	1	(14.2)	8.18 (0.97-68.35)	
Clinical manifestations related to FS‖	5581	78	(1.4)	1.00	**<0.001**
Fever	2730	90	(3.3)	2.40 (1.76-3.26)	
No					
Yes					
Cough					
No	4058	40	(1.2)	1.00	**<0.001**
Yes	4267	129	(2.6)	2.17 (1.52-3.11)	
Myalgia					
No	6578	94	(1.4)	1.00	**<0.001**
Yes	1715	74	(4.3)	3.11 (2.28-4.23)	
Odynophagia					
No	5209	128	(2.4)	1.00	**<0.001**
Yes	3075	41	(1.3)	0.53 (0.37-0.76)	
Headache					
No	3890	84	(2.6)	1.00	**0.004**
Yes	4435	85	(1.7)	0.64 (0.47-0.87)	
Runny nose					
No	3563	69	(1.5)	1.00	**<0.001**
Yes	4733	99	(2.8)	1.93 (1.41-2.63)	
Anosmia					
No	5701	121	(2.1)	1.00	0.471
Yes	2554	48	(1.9)	0.88 (0.63-1.23)	

Warning signs/Severity					
Dyspnea					
No	7553	119	(1.6)	1.00	**<0.001**
Yes	772	50	(6.5)	4.32 (3.08-6.07)	
Arterial Hypotension					
No	8105	156	(2.0)	1.00	**<0.001**
Yes	220	13	(6.0)	3.20 (1.78-5.70)	
Performed test for COVID -19					
No	4712	89	(1.9)	1.00	0.296
Yes	3613	80	(2.2)	1.17 (0.86-1.59)	
Result of the test for COVID-19					
Negative	6059	100	(1.6)	1.00	**<0.001**
Positive	2266	69	(3.0)	1.87 (1.37-2.55)	
Received referral to UBS¶					
No	8032	166	(2.0)	1.00	0.213
Yes	293	3	(1.0)	0.49 (0.15-1.54)	
Received referral to UPA#					
No	7784	133	(1.7)	1.00	**<0.001**
Yes	541	36	(6.6)	4.10 (2.80- 5.99)	

Note: *Excluded missing data; † OR (CI) = Odds Ratio (95 % confidence interval); ‖FS = Flu-like Syndrome; §BMI = Body Mass Index; ¶UBS: Basic Health Unit; #UPA: Emergency Care Unit.

Source: prepared by the authors.

The final model of multiple logistics regression showed that the factors independently associated with hospitalization by SARS were: being male (OR_{aj}: 2.04; CI95% 1.46-2.85); age between 40 and 59 years (OR_{aj}: 4.09; CI95% 2.65-6.32) or greater than 60 years (OR_{aj}: 14.86; CI95% 9.33-23.68); report diagnosis of rheumatological diseases (OR_{aj}: 2.50; CI95% 1.11-5.62) or cancer diseases (OR_{aj}: 3.02; CI95% 1.27-7.16); report fever (OR_{aj}: 2.06; CI95% 1.48-2.87); cough (OR_{aj}: 1.67; CI95% 1.13-2.45); myalgia (OR_{aj}: 2.54; CI95% 1.81-3.57); or runny nose (OR_{aj}: 1.93; CI95% 1.38-2.70); and finally report the presence of dyspnea (OR_{aj}: 3 00; IC95% 2.05-4.39) (Table 3). Multicollinearity was not found among the explanatory variables evaluated in the study. The Hosmer-Lemeshow test was suitable for final model adjustment (X2 = 7.06; degrees of freedom (df) = 8; p = 0.5298). Specifically for age, it is possible to realize that as age increases, the chance of hospitalization also increases, configuring a dose-response gradient (Table 3).

Table 3 - Final Model of Multiple Logistics Regression of the factors associated with hospital hospitalization of patients attended by the structured teleconsultation and telemonitoring service and suspected cases in the acute phase of COVID-19 (Telecovid-MG). Divinópolis, MG. Brazil. 2023 (n = 8,325)

Variables	OR_{aj} * (CI†95%)	P Value‡
Sex		
Female	1.00	**<0.001**
Male	2.04 (1.46-2.85)	
Age		
18-39 years	1.00	
40-59 years	4.09 (2.65-6.32)	**<0.001**
60 years +	14.86 (9.33-23.68)	**<0.001**
Dyspnea		
No	1.00	
Yes	3.00 (2.05-4.39)	**<0.001**
Fever		
No	1.00	
Yes	2.06 (1.48-2.87)	**<0.001**
Cough		
No	1.00	
Yes	1.67 (1.13-2.45)	**0.009**
Myalgia		
No	1.00	
Yes	2.54 (1.81- 3.57)	**<0.001**
Runny nose		
No	1.00	
Yes	1.93 (1.38-2.70)	**0.001**
Rheumatological diseases		
No	1.00	**0.026**
Yes	2.50 (1.11-5.62)	
Oncological diseases		
No	1.00	**0.011**
Yes	3.02 (1.27-7.16)	

Note: Hosmer-Lemeshow Test: P = 0.5298; * OR_{aj} = adjusted Odds Ratio; †CI = confidence interval.

Source: prepared by the authors

DISCUSSION

The results showed the high resolution of TeleCOVID-MG in the conduct and clinical management of adult patients with mild to moderate COVID-19, as a low proportion of cases required hospitalization (2.0 %). Similarly, a French cohort monitored 43,103 patients by telehealth and identified a small proportion of patients with COVID-19 with clinical worsening (4.1 %) and the need for hospitalization (4.0 %)[25].

The severe forms of COVID-19 occur, primarily, in patients with advanced age and with pre-existing comorbidities[26]. The present investigation pointed out that patients with obesity, SAH, DM, and chronic heart disease had a greater prevalence of SARS hospitalization, which maintained independently significant association with the presence of other less common comorbidities, including chronic nephropathies, and chronic rheumatological and oncological diseases. National[18,27] and international[25,28] evidence support this finding, indicating that the presence of comorbidities such as SAH, pneumopathies and chronic heart disease, obesity, DM, immunosuppression, cancer and chronic kidney disease are potential risk factors for evolution to serious forms and death by COVID-19[29-30].

After a mean period of four days of symptoms, the main clinical manifestations informed by patients at the beginning of telemonitoring by TeleCOVID-MG were headache, cough, and runny nose. Similar findings were found in a national study, with greater frequency of headache (41.8 %), cough (33.3 %), and runny nose (30.0 %), with three days being the mean period between the onset of symptoms and the search for attendence[18]. In contrast, an international study described fatigue (85.9 %), cough (61.9 %), chills (54.0 %), myalgia (54.0 %), dyspnea (49.3 %) and fever (48.5 %) as the most frequent symptoms[28].

It is noteworthy that 11.0 % of patients reported presenting some warning sign or severity signal (dyspnea or hypotension), and 3.5 % of patients were referred for UBS evaluation and 6.5 % for urgent care evaluation. Other national studies have shown higher proportions of referral for in-person assessment in health services. In an MG study, 11.9 % of patients were referred for in-person assessment in an outpatient clinic and 3.1 % to the hospital[18]. In contrast, in a study conducted in São Paulo it was observed that 25 % of patients were referred for emergency service evaluation, with 29.4 % presenting dyspnea[27].

The use of telemedicine may increase the patient's referral, as the identification of warning or decompensation of comorbidities through self-reporting during the interview usually refer to the need for an in-person clinical investigation[25]. In contrast, some studies show that patients with COVID-19 treated and monitored by the telehealth service have less need for emergency service, lower hospitalization risk, and lower mortality[28,31]. In this sense, a Spanish study compared the proportions of hospitalizations in two assistance modalities (telehealth and in-person care). The group of patients monitored by telehealth presented 1.3 hospitalizations for 1,000 inhabitants and lower demand for an emergency sector when compared to those who were monitored in-person (1.8 hospital hospitalizations for 1,000 inhabitants). Thus, the study showed a reduction in hospital overload and lower mortality rate with the use of telehealth[28].

The results presented showed that only 43.4 % of patients reported a specific test for COVID-19, and of these, 62.6 % reported a positive result, with a higher proportion of hospitalizations among patients who reported a positive result. This testing proportion was similar to that found in a national study, in which 62.8 % of patients treated were indicated for testing, 76.4 % of these underwent the test, and only 14.5 % tested positive for COVID-19[18].

It is important to emphasize that TeleCOVID-MG followed the guidelines and service flowchart proposed by SEMUSA and the MH, therefore, testing for COVID-19 was made available to patients treated and monitored according to the availability of testing kits and the criteria defined at each moment of the pandemic. However, the low testing frequency observed in this study may be related to the data collection period, as it spanned the first (February to July 2020), second (November 2020 to April 2021), and part of the third (December 2021 to May 2022) waves of COVID-19 in the country. In addition, the population's accessibility to diagnostic tests varied throughout the pandemic. During the first wave, when the Alpha variant predominated, there were practically no specific diagnostic tests available in the SUS network. In contrast, during the second and third waves, with the Gamma and Omicron variants predominating respectively, the indications for testing varied, with periods of prioritization of testing of patients with severe conditions or with risk factors for complications, depending on the demand for care and available stock in the network. This reflects the inequality and disparity in developing regions and countries in relation to dealing with the pandemic, where there was less availability of tests, often with uncertain technical quality, making mass testing of the population impossible, especially in the first months of the pandemic[32].

The findings of this study showed that male gender, presence of rheumatological and oncological comorbidities, acute symptoms (fever, cough, myalgia, and runny nose), and dyspnea (warning sign or severity) were factors independently associated with hospitalization for SARS in adult patients monitored by TeleCOVID-MG. Similarly, male gender, advanced age, obesity, kidney disease, or cancer under treatment were factors associated with clinical worsening in COVID-19 patients treated via telehealth in a French cohort[25]. Clinical worsening contributes to increased hospitalization and death rates among patients. Despite this, it is rare among outpatients with mild symptoms when compared with more severe forms of the disease[25].

Similarly, a review demonstrated that the most severe cases of the disease that progressed to SARS were more likely to be elderly patients, male patients, and patients with comorbidities or risk factors, when compared with patients with mild clinical symptoms[30]. A national study identified a higher risk of death from COVID-19 in males when compared to females, in older people (over 80 years old) and with some comorbidity[33]. This can be explained by the lower accessibility to health services and the later seeking of medical care by males[34].

In this context, the identification of factors associated with hospitalization can be a good predictor for the recognition of warning signs or severity, thus contributing substantially to therapeutic decision-making by the health team. Systemic monitoring of patients with risk factors significantly reduces hospitalizations, in addition to contribu-

ting to the simultaneous management of a larger contingent of people. Telemedicine can be a useful tool in the early identification of symptoms and in the rapid referral of the most serious cases to in-person services[28].

There is a lack of published studies using telehealth as a care modality for patients with acute infectious conditions, as the literature has shown the use of telehealth in the context of evaluation and monitoring of patients with chronic diseases[13,19]. In addition, few studies have been published in Brazil on suspected or confirmed cases of COVID-19 involving patients with respiratory symptoms monitored by ICT during the pandemic[17-18,27]. It is noteworthy that the analysis of satisfaction with the care provided by TeleCOVID-MG demonstrated that the service contributed significantly to the local fight against the pandemic, improving access, resolution, and quality of care for the population[35].

In addition, the remote care modality may have contributed to reducing the circulation of the virus, the contamination rate, and the spread of the disease in the community during the pandemic, also making it possible to reduce the care burden of in-person health services. Other studies show that home monitoring through telemedicine promoted a decrease in in-person care in hospitals and a consequent reduction in the mortality rate, as well as a reduction in the overload on services, improvement in the quality of care, reduction in financial expenses and a reduction in the rate of readmission due to complications from COVID-19[18,25,36].

The limitations of this study are related to the use of secondary databases, which may present information bias. During the usual process of recording information in the TeleCOVID-MG system, there may have been typing, storage, or data export errors, in addition to potential inconsistencies in the records in SIVEP-Gripe. However, several methodological strategies were used to reduce bias and increase internal and external validity. In addition, this is an evaluation of robust information from the large population served by TeleCOVID-MG throughout its period of operation, thus enabling the expansion of scientific knowledge in the area of telehealth applied to combating the COVID-19 pandemic.

The possibility of respondent bias and memory bias on the part of patients is highlighted, since several clinical data were self-reported during teleconsultations and telemonitoring. Another aspect to be considered is the possibility of observer bias when recording clinical information in the TeleCOVID-MG system fields, which may result in omission or error in recording information by the professional. However, it is noteworthy that the research team adopted strategies to avoid the occurrence of biases throughout the process, including periodic training and the development of well-defined clinical and research protocols, including the standardization of language through structured scripts and manuals. Finally, the cross-sectional design makes it impossible to establish causality between the explanatory variables and the outcome analyzed in this study. Therefore, it is suggested that future studies on the subject be carried out, using other methodological designs that allow for a better assessment of causality.

The findings of this study may contribute to the structuring of healthcare models involving the use of ICT, in addition to proposing guidelines for the development of cri-

teria for use in situations of new outbreaks or new epidemics. Telehealth becomes another alternative for healthcare provision to the population, in addition to existing in-person services, helping to meet the priorities and needs of the community[11,17]. Therefore, the training and experience of healthcare professionals in managing the telehealth process are essential to achieve a high level of adherence by the population and to offer quality remote care. This care model can be highly effective, as long as it is well structured to meet demands and identify the population at risk for severe forms of COVID-19[28].

CONCLUSION

This study found that male gender, age between 40 and 59 years, and over 60 years, presence of rheumatological or oncological comorbidities, acute symptoms (fever, cough, myalgia, and runny nose), and dyspnea as a warning sign were factors independently associated with hospitalization for SARS among adult patients treated and monitored by TeleCOVID-MG. Age over 60 years was the characteristic most strongly associated with hospitalization. Therefore, it is important to identify pre-existing risk factors that are associated with severe forms of COVID-19. The identification of warning signs or severity during telecare by health professionals stands out as an essential strategy in the clinical management of the patient for in-person referral, reducing more severe complications.

The findings may also contribute to the strategic planning of the health care network in line with in-person health services at their different hierarchical levels, through knowledge of the clinical and epidemiological profile of patients with COVID-19. Therefore, it is necessary to establish specific criteria for eligibility for remote assistance, considering in-person assessment and monitoring especially for elderly people, with pre-existing comorbidities and acute flu-like symptoms.

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Authors' contributions

Menezes AC, Cardoso CS, Oliveira CRA, Seixas AFAM, Silva HKC, Mendes MS, Ribeiro ALP and Rocha GM contributed to the study design, data analysis and interpretation, writing of the article, relevant critical review of the intellectual content and approval of the final version to be published.

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Conflict of interest

There is no conflict of interest.

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